Simpson

INSTRUMENTS THAT STAY ACCURATE

INSTRUCTION MANUAL

SELF POWERED CALIBRATOR

MODEL 2600

SIMPSON ELECTRIC COMPANY
5200 W. Kinzie St., Chicago 44, Illinois, EStebrook 9-1121
In Canada, Bach-Simpson, Ltd., London, Ontario

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SIMPSON SELF POWERED CALIBRATOR – MODEL 2600 – INSTRUCTION MANUAL
ERRATA SHEET

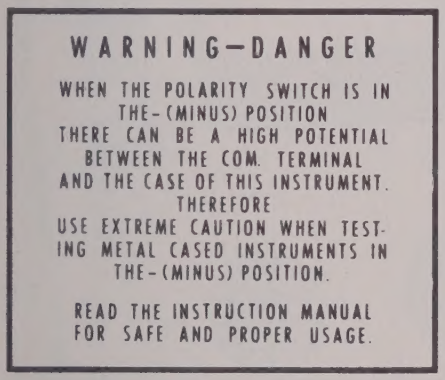
PURPOSE

The purpose of this correction sheet is twofold. First it is intended to correct some minor errors that appeared in the original manual. Second, and by far the most important, is to point out that the Model 2600 can be used for A.C. voltage calibration over a wide frequency range with full accuracy. Stated briefy, the Model 2600 can be used for A.C. voltage calibration over the frequency range of 50 to 2000 C.P.S., and over the temperature range of 45° to 110° F with an accuracy of ±¾% of Full Scale.

Make the following changes in your Instruction Manual for the Simpson Self Powered Calibrator Model 2600.

On Page 4, Figure 1.

An adhesive-backed aluminum "CAUTION" label, like the illustration below, should appear on the front panel. It should be located centrally between the two meters. If your Calibrator does not have this label, request one from the Sales Department, Simpson Electric Company, 5200 W. Kinzie St., Chicago 44, Illinois; you will receive the label, together with installation instructions, prints SK848 and 1–117875. Simply make your request read "One – Caution Label, Simpson Part Number 1–117875".


WARNING—DANGER
WHEN THE POLARITY SWITCH IS IN THE-(MINUS) POSITION THERE CAN BE A HIGH POTENTIAL BETWEEN THE COM. TERMINAL AND THE CASE OF THIS INSTRUMENT. THEREFORE USE EXTREME CAUTION WHEN TESTING METAL CASED INSTRUMENTS IN THE-(MINUS) POSITION.
READ THE INSTRUCTION MANUAL FOR SAFE AND PROPER USAGE.

On Page 5, Line 3.

After "A.C. VOLTAGE RANGES", add; (50 cps to 2000 cps).

On Page 5, Line 10 under "DIRECT CURRENT RANGES".

Under "RANGES FOR MICROAMPERES", delete (Maximum output 6 volts).

Under "RANGES FOR MILLIAMPERES", change (Maximum output 6 volts) to read; (Nominal output at maximum load 3 volts).

On Page 5, Line 13.

Change "(Maximum output 5 volts)" to read; (Nominal output at maximum load 2.5 volts).

On Page 5, following boxed specifications.

Change "POWER INPUT: 117 volts, 60 cycles, single phase A.C." to read;

POWER INPUT:

for D.C. Calibration: 115-125 volts, 50 to 60 cycles, single phase A.C.

for A.C. Calibration: 100-125 volts, 50 cycles to 2000 cycles, single phase A.C.

On Page 5, following boxed specifications (Continued)

Change "NORMAL POWER CONSUMPTION: approximately 50 watts (approx. 150 watts for high D.C. ampere output" to read;

NORMAL POWER CONSUMPTION: this varies with the externally connected load and with the output selected; approximately 30 to 200 watts.

On Page 9, under "POWER INPUT REQUIREMENTS".

Replace the entire paragraph with the following information:

The Simpson Self Powered Calibrator requires single phase power at a voltage level from 115 to 125 v. RMS for D.C. calibration, and 100 to 125 v. RMS for A.C. calibration. For D.C. calibration the power supply frequency should be 50 to 60 C.P.S. For A.C. calibration the frequency of the power source will be determined by the requirements of the instrument under test; however, the Model 2600 will accomodate any frequency from 50 to 2000 C.P.S. with the full accuracy stated on page 3 of the Instruction Manual.

For either A.C. or D.C. calibration the power requirements of the Model 2600 will be determined primarily by Model 2600 function selected and the loading of the instrument connected to the output. Normal power consumption for the Model 2600 varies from approximately 30 to 200 watts.

On Page 9, under "REGULATED VOLTAGE ADVISED", Line 7.

Change "...at least a 150 watt..." to read; ...at least a 200 watt...

On Page 9, under "TURNING ON THE CALIBRATOR", LINES 2 and 3.

Change "...into a source of 117 volts single phase 60 cycle A.C. power." to read;

...into a source of 117 volts single phase A.C. power; frequency must be 50 to 60 cycles for D.C. calibration, or any frequency from 50 cycles through 2000 cycles for A.C. calibration.

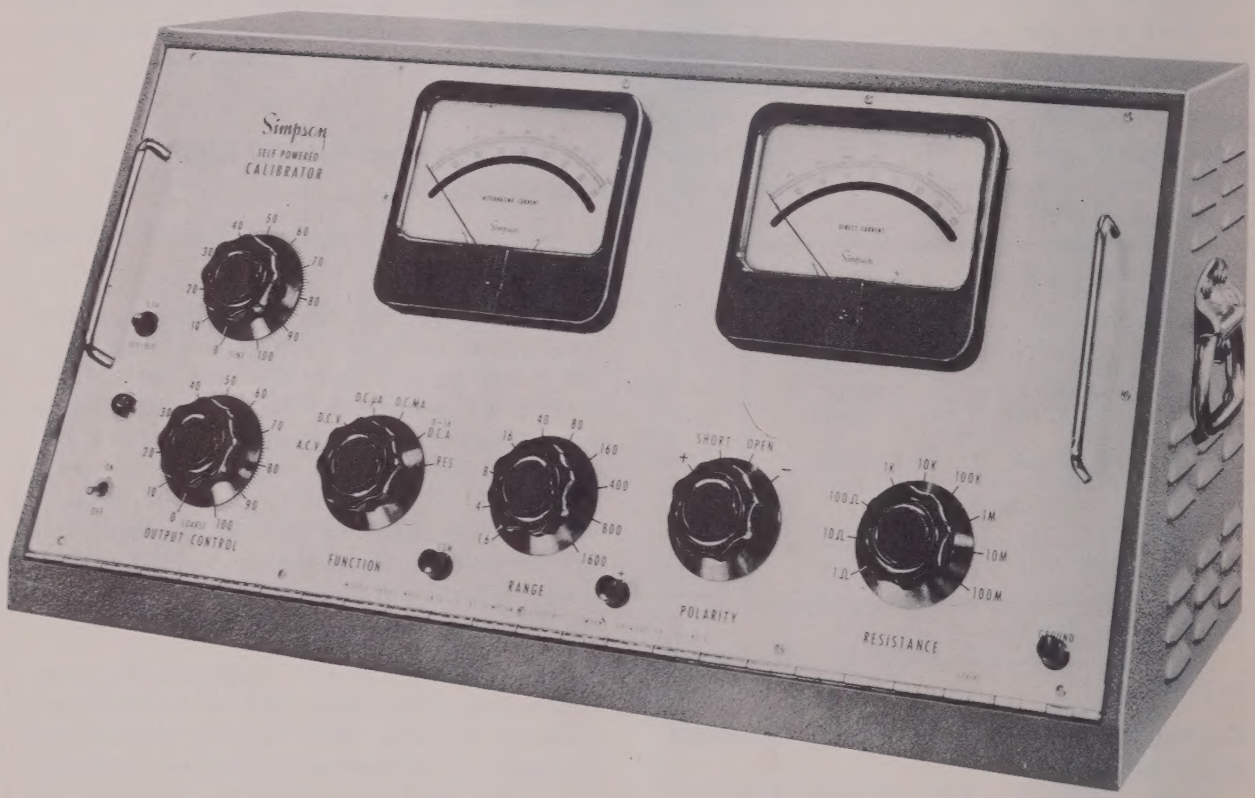


FIGURE 1. THE SIMPSON SELF POWERED CALIBRATOR MODEL 2600.

SIMPSON SELF POWERED CALIBRATOR MODEL 2600

ELECTRICAL AND MECHANICAL SPECIFICATIONS

A.C. VOLTAGE RANGES

All ranges continuously variable. Voltages shown on A.C. voltmeter. Accuracy of direct reading at 77° F (25° C), ±0.75% of full scale.

A.C. VOLTAGE RANGES 0 to	MILLIAMPERES MAX. LOADING	A.C. VOLTAGE RANGES 0 to	MILLIAMPERES MAX. LOADING
1.6	*250	80	100
4.0	500	160	200
8.0	250	400	100
16.0	312	800	100
40.0	100	1600	100

*437 milliamperes for an overall accuracy of ± 1.75% of full scale

D.C. VOLTAGE RANGES

All ranges continuously variable. Voltages shown on D.C. voltmeter. Accuracy of direct reading at 77° F (25° C), ±0.5% of full scale.

D.C. VOLTAGE RANGES 0 to	*MILLIAMPERES MAX. LOADING	D.C. VOLTAGE RANGES 0 to	*MILLIAMPERES MAX. LOADING
1.6	8	80	9
4.0	8	160	9
8.0	8	400	10
16.0	8	800	10
40.0	8	1600	10

*Maximum loading to obtain full scale deflection on D.C. voltmeter of Model 2600 when line voltage is 105 v RMS. If full scale deflections are not required, any range may be loaded up to a maximum of 10 milliamperes. Under no circumstances should more than 10 milliamperes be drawn from the Model 2600 D.C. power supply for any extended period of time.

DIRECT CURRENT RANGES

All ranges continuously variable. Currents shown on D.C. meter. Accuracy of direct reading at 77° F (25° C), ±0.5% of full scale. See page 6 for correction factor for the microampere ranges.

RANGES FOR MICROAMPERES 0 to	RANGES FOR MILLIAMPERES 0 to
1.6, 4.0, 8.0, 16, 40, 80, 160, 400, 800, 1600.	1.6, 4.0, 8.0, 16, 40, 80, 160, 400, 800, 1600.
(Maximum output 6 volts)	(Maximum output 6 volts)

RANGE FOR AMPERES
0 to 16

(Maximum output 5 volts)

RESISTANCE VALUES

All resistance values are fixed. Value connected across output terminals shown by RESISTANCE switch position. Standard accuracy ±1.0% for values up through 10 megohms, and ± 2% for the 100 megohm resistor.

RESISTANCE VALUES

1 ohm
10 ohms
100 ohms
1,000 ohms (1K)
10,000 ohms (10K)
100,000 ohms (100K)
1,000,000 ohms (1M)
10,000,000 ohms (10M)
100,000,000 ohms (100M)

POWER INPUT: 117 volts, 60 cycles, single phase A.C.

NORMAL POWER CONSUMPTION: approximately 50 watts (approx. 150 watts for high D.C. ampere output).

SIZE: 31" wide by 15" high by 15" deep.

WEIGHT: 135 pounds.

WARNING – DANGER

This instrument can deliver voltages which are dangerous to touch. Prevent injury, or even death, by setting both output controls at zero and turning power off before touching the binding posts, leads, or any instrument which is connected.

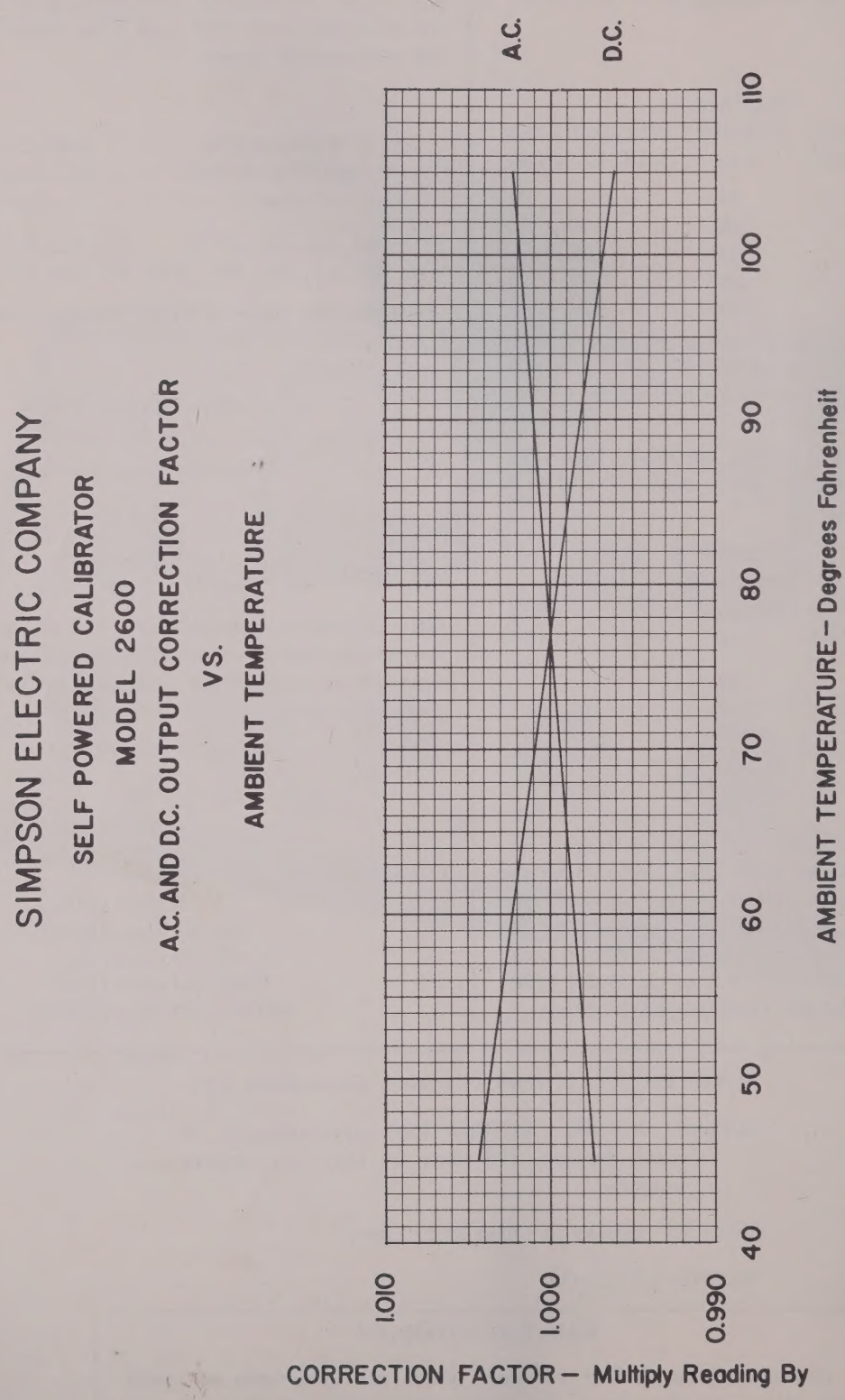


FIGURE 2. CORRECTION FACTORS FOR A NORMAL RANGE OF AMBIENT TEMPERATURES.

SECTION I

GENERAL DESCRIPTION

PURPOSES

The Simpson Self Powered Calibrator Model 2600 is a semi-portable piece of laboratory type equipment which will produce known and indicated electrical conditions. It will produce accurately metered voltages and currents, and it also contains a group of assorted values of accurate resistances.

APPLICATIONS

The main applications for this equipment are test, repair, maintenance, and calibration of electrical indicating instruments. When the accurate electrical conditions produced by the Self Powered Calibrator are applied to electrical meters, they can be expected to produce the required deflections in the meters which are connected. Evaluation of the meter deflection, and comparison to expected deflection, will show the condition of the indicating meter and/or its circuit.

The Calibrator may also be used as an accurate source of D.C. and A.C. voltages for other applications, providing the loads are not greater than those shown in the specifications on page 3. The Calibrator can be used for such applications as a source of differential voltages or for checking a zero current voltmeter.

OUTPUTS AVAILABLE

The Simpson Self Powered Calibrator Model 2600 produces A.C. voltages, D.C. voltages, and Direct Current, all continuously variable through a very wide range of values. It also contains nine values of fixed resistance, any of which may be connected directly between the output terminals. The electrical specifications for the output connections are shown on page 3.

OUTPUT ACCURACY

The Self Powered Calibrator furnishes DC voltages and currents through the output circuit with an accuracy of ±0.5% when the ambient temperature is 77° F (25° C). Accuracy for AC voltages is ±0.75% at the same ambient temperature. For temperature correction with ambient temperatures between 45° F and 105° F (7.2° C and 40.6° C), see figure 2. Each resistor with a value up to 10 megohms is furnished with an accuracy of ±1%; the 100 megohm resistor has an accuracy of ±2%.

TEMPERATURE CORRECTION

Figure 2 shows the correction curves for the Simpson Self Powered Calibrator Model 2600. These curves permit the operator to apply appropriate corrections to the readings obtained on the Calibrator for ambient temperatures other than 77° F (25° C), the temperature at which the Calibrator was standardized. These curves need only be used when the unit is operated with ambient temperatures considerably different from 77° F and the ultimate limits of accuracy are required.

The curves are based on the following temperature coefficients for the Model 2600, which were obtained experimentally in the Simpson Standardizing Laboratory:

A.C. correction for all ranges = −0.008% per degree F.

D.C. correction for all ranges = +0.0133% per degree F.

These coefficients can be used directly, independent of the curves shown in figure 2. Be careful to use the correct algebraic sign for each correction.

Examples:

1. Assume that the Calibrator is being used in an ambient temperature of 55° F (12.8° C). The D.C. voltmeter indicates 149.1 volts applied to the instrument under test. Referring to figure 2, the correction factor for 55° F is 1.003. Multiply the reading, 149.1 by the correction factor, 1.003. This product is 149.55. The Calibrator is, then, actually delivering 149.55 volts D.C. within ±0.5%.

2. Assume that the Calibrator is being used for A.C. voltage where the ambient temperature is 102° F (39° C). The A.C. voltmeter on the Calibrator indicates 675.0 volts. Referring to the A.C. curve in figure 2, the correction factor is 1.002. Multiplying 675.0 by 1.002 yields 676.4. This means that 676.4 volts (±0.75%) A.C. is being delivered to the instrument under test.

CORRECTION FACTOR FOR MICROAMPERE MEASUREMENTS

When the Simpson Self-Powered Calibrator Model 2600 is used to test microammeters, the internal circuit in the Calibrator includes a series resistance of 1 megohm. If the resistance of the microammeter under test is low (1000 ohms or less), the correction factor may be disre-

garded. But when the resistance of the microammeter is greater, current through the meter under test will be less than the current shown on the Standard Meter, and a correction factor must be applied to the reading to obtain an accurate indication.

The correction factor for each meter under test is determined by the following formula:

$$\text{Correction Factor} = \frac{10^6}{10^6 + R_M}$$

where R_M is the meter resistance in ohms.

To determine the actual current through the meter under test, first calculate the correction factor with the above formula, and then multiply the current indicated on the Standard Meter by the correction factor. This will bring the expected current within ±0.5% accuracy of full scale.

Figure 3 shows correction factors for meter resistances up through 25,000 ohms, and may be used instead of the formula if desired. In either case, after the correction factor is determined, multiply the indicated current on the Standard Meter by the correction factor.

For example, suppose a microammeter with an internal resistance of 10,000 ohms is under test. The correction

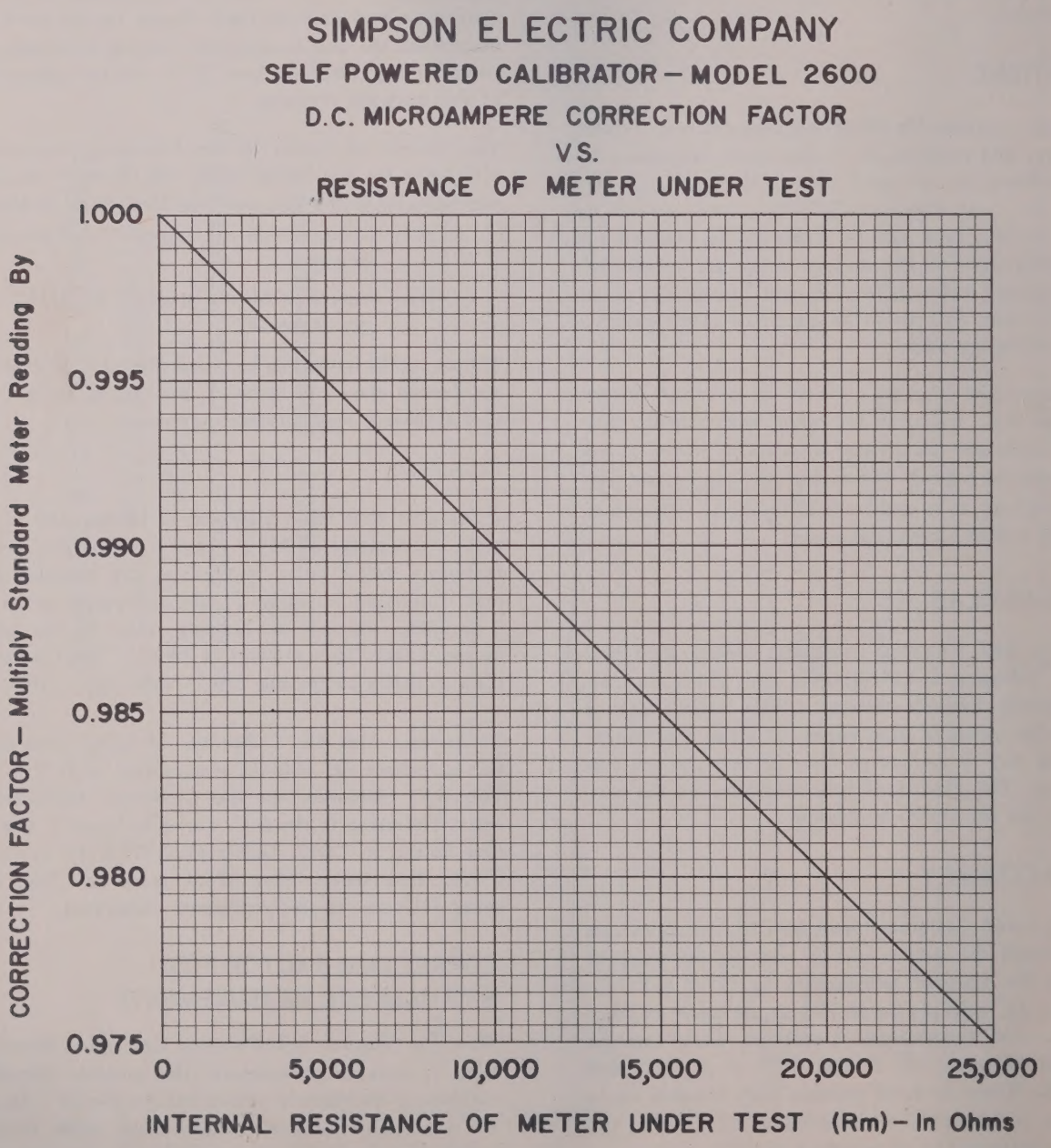


FIGURE 3. D.C. MICROAMPERE CORRECTION FACTOR VS. RESISTANCE OF METER UNDER TEST

factor, according to Figure 3, is 0.990. According to the formula, the factor is 0.9901, showing that the figure is sufficiently accurate for use in this range of resistances. Suppose the Standard Meter reads exactly 5 microamperes for a test application; the meter under test should read 5 times 0.990, or 4.95 microamperes.

If the resistance of the meter under test is not known, it can be determined with the aid of a vacuum tube voltmeter and the microampere circuit of the Calibrator. It cannot usually be measured with an ohmmeter or a wheatstone bridge, because the current through the measuring circuit of these devices is enough to overload the meter severely and damage it.

Connect the meter to be tested in the microampere circuit of the Calibrator, and connect the vacuum tube voltmeter across the meter to be tested. Apply power from the Calibrator sufficient to cause a readable deflection on both the Standard Meter and the vacuum tube voltmeter, but not enough to overload the meter under test. Then read the Standard Meter and the vacuum tube voltmeter. Use this formula to calculate meter resistance:

$$R_M = \frac{E_M \times 10^6}{E_S - E_M}$$

where R_M = Resistance of meter under test in ohms,

E_S = Voltage indicated on Standard Meter,

and E_M = Voltage across meter under test, read with vacuum tube voltmeter.

Note that the indication on the Standard Meter for microampere measurements is actually the number of D.C. volts applied across the external circuit and the internal series 1 megohm resistor.

POWER INPUT REQUIREMENTS

The Simpson Self Powered Calibrator requires a single phase, 117 volts 60 cycle AC power input for all voltage and current measuring applications. This power is furnished to the self-contained power supply, which in turn furnishes the adjusted and metered quantities through the output terminals on the front panel. Normal power consumption is about 50 watts, but this increases to about 150 watts when the output is furnishing high amperage Direct Current.

REGULATED VOLTAGE ADVISED

It is recommended that the input voltage for the Self Powered Calibrator be regulated in order to maintain steady values of voltage and current during periods of use. Any fluctuation of the input voltage will result in a fluctuation in the instrument's output. but does not effect the accuracy.

The voltage regulator requires at least a 150 watt capacity. In addition to this, it should be of a 'non-saturable' type to assure a sine wave input for the Calibrator. If the input waveshape is distorted, errors will result for A.C. voltage applications.

CONTROLS

The controls on the front panel are positioned for maximum efficiency during use. Beginning at the left of the front panel, the controls and their functions are as follows:

ON-OFF SWITCH. PILOT LAMP AND FUSE	Controls power input circuit to self-contained power supply.
FINE OUTPUT CONTROL	Vernier adjustment for all voltage and current output values.
COARSE OUTPUT CONTROL	Coarse adjustment for all voltage and current output values.
FUNCTION	Selects type of output; its positions are marked A.C.V. D.C.V., D.C.uA., D.C.M.A., 0-16 D.C.A., and RES.
RANGE	Selects ranges for all voltage and current outputs except 0-16 amperes D.C.; its positions are marked 1.6, 4, 8, 16, 40, 80, 160, 400, 800, and 1600.
POLARITY	Reverses D.C. polarity for output terminals, and provides for shorted and open circuits for ohmmeter tests; its positions are marked +, SHORT, OPEN, and −.
RESISTANCE	Selects which of the nine accurate resistances is connected across the output terminals when the FUNCTION switch is set at RES.

METERS

There are two large indicating meters on the front panel of the Self Powered Calibrator. One measures all outputs

from the instrument for direct current applications, both voltage and current; and the other measures all A.C. voltage outputs. Each is a 7-inch meter with an arc length of 5.9 inches and a 90° deflection. Each has a mirrored scale which will be used to eliminate parallax error during reading. Each has 160 hand-stepped scale divisions, with three arcs marked from 0 to 400, 0 to 800, and 0 to 1600.

DC METER

The D.C. meter, at the right hand side on the front panel, has a hand-drawn dial. Any deflection sensitivity variations which may occur in the individual meter are corrected by this method. To retain its accuracy over a very long period of time, the movement is one of the special Simpson Deep Core types. The movement is self-shielding, and will prevent erratic deflection from occuring due to extraneous external fields.

AC METER

The A.C. meter is at the left on the front panel. It is similar to the D.C. meter described above, with a special Simpson Deep Core Movement and its advantages, and with a hand-drawn dial. A.C. voltages which are measured with this meter are rectified in a full-wave bridge type circuit.

OUTPUT TERMINALS

There are two binding post terminals near the center at the bottom of the front panel of the Self Powered Calibrator. These are marked COM. and ±. They are the connection points for the two terminals of the meter which is to be tested. If the meter operates on DC, the polarity switch above and to the right of these terminals will determine which of the terminals is positive and which is negative.

GROUND TERMINAL

The GROUND binding post is located at the lower right corner of the front panel. Connect a length of #12 A.W.G. (or larger) wire from this post to the nearest convenient water pipe, radiator (in a steam or hot water heating system), or earth ground to prevent any static accumulation in the Self Powered Calibrator.

RELAYS IN AMPERE OUTPUT CIRCUIT

When the FUNCTION switch is set at 0–16 D.C.A., there are two relays inside the Self Powered Calibrator which are activated. Their contacts carry the high current directly from the power supply to the output terminals. This will prevent large amounts of current from passing through the switch contacts of the instrument. There is neither range selection nor polarity reversal for this circuit. The output terminals receive negative polarity at the left (COM.) and positive polarity at the right (±).

PHYSICAL DESCRIPTION

The Simpson Self Powered Calibrator Model 2600 is enclosed in a heavy gauge steel case with ample louvers for cooling the components. The front panel slopes at a 30° angle for convenience in handling the controls and reading the meters. The panel is etched aluminum with a steel backing for support. It is hinged at the bottom for easy access to the internal components without disturbing any of the circuits. A convenient handle at each side of the front panel facilitates handling of the front panel for cleaning or repair.

The overall dimensions of the Self Powered Calibrator are 15 inches high by 15 inches deep by 31 inches long. The instrument weighs 135 pounds.

CAUTION

Do not set the POLARITY switch at SHORT or touch the leads together, even momentarily, when the FUNCTION switch is set at A.C.V. or at 0–16 D.C.A.

SECTION II

THEORY OF OPERATION

FOR TESTING VOLTMETERS

When the Simpson Self Powered Calibrator Model 2600 is used to evaluate a voltmeter, either A.C. or D.C., the instrument will both produce and measure the voltage which is applied to the voltmeter and its circuit. The method ir which the Self Powered Calibrator operates will automatically compensate for any normal loading effect which occurs due to the external meter circuit.

The maximum output current from the Self Powered Calibrator, with the FUNCTION switch set at D.C.V. is expressed in terms of milliamperes for each range; this is shown in the electrical specifications on page 3. When these loads are not exceeded, the output can be adjusted to a full scale reading for each range, providing the line voltage is at least 105 volts RMS. The maximum of 10 milliamperes can be used for any range, but the maximum voltage available from the lower ranges will be only about ¾ of the full scale value under this loading condition.

FOR TESTING DIRECT CURRENT METERS

For evaluating a D.C. microammeter, milliammeter, or ammeter, the Simpson Self Powered Calibrator Model 2600 will both produce and measure the current which goes through the meter and its circuit. The method in which the Self Powered Calibrator operates will automatically compensate for any normal loading effect due to the external meter circuit.

For microampere measurements, measured D.C. voltage is connected through a one megohm series resistor, with an accuracy of ±0.1%, to the meter under test. The D.C. meter on the Calibrator will indicate the number of volts applied to the circuit. If the meter under test has a low resistance, the current through its circuit will be the same number of microamperes. If the resistance of this meter is high, its current will be limited to less than the number of microamperes indicated by the Standard Meter. See the information under Correction Factor, page 5, to determine the relation between indicated current and true current for each application of the microampere circuit. Note that the Standard Meter, on the Calibrator, will indicate, whether there is actually any current passing through the external circuit or not.

For milliampere measurements, the direct current is produced through a full wave selenium rectifier and supplied to a series circuit in which the external meter is in series with the D.C. meter of the Calibrator. Note that the Calibrator D.C. meter will indicate only when there is actually some current passing through the external meter circuit.

For ampere measurements, the same type of series circuit is used as for milliampere measurements. To prevent the high amounts of current from passing through the switch circuit of the Calibrator, two current relays are actuated and will close the current circuit for the external meter under test.

FOR TESTING OHMMETERS

For evaluating an ohmmeter, the Self Powered Calibrator connects any one of nine known values of accurate resistance across the output terminals. The accuracy with which an ohmmeter, connected across the output terminals, indicates each of the resistance values will show how accurate it is. The self-contained power supply in the Calibrator is not involved in the output circuit for resistance measurements.

WARNING – DANGER

Values of D.C. microamperes are obtained by applying a known voltage through a 1 megohm series resistor to the output terminals. The number which can appear at the front panel terminals is equal to the number of microamperes indicated on the Standard Meter: i.e., 400 uA – 400 volts; 800 uA – 800 volts; 1600 uA – 1600 volts! Always reduce both OUTPUT controls to 0 and turn power off before touching the binding posts, leads, or meter under test.

SECTION III

OPERATION

VOLTAGE AND CURRENT CIRCUITS

TURNING ON THE CALIBRATOR

Connect the power cord plug for the Simpson Self Powered Calibrator into a source of 117 volts single phase 60 cycle A.C. power. If a voltage regulator is used, as recommended, be sure that the regulator is turned on. Then, with the OUTPUT CONTROLS set at zero, and with no output connections, set the power switch at ON. The pilot lamp will indicate that power is applied to the Calibrator. Allow at least 30 seconds for the vacuum tube inside the instrument to heat.

CHECK THE ZERO INDICATION

Most indicating meters have a mechanical adjustment for a zero indication. Before you test a meter with the Simpson Self Powered Calibrator Model 2600, check to see that the meter pointer rests over the zero mark on the scale with no current passing through it.

If the pointer does not rest over its zero mark, *carefully* turn its adjusting screw to position the pointer over zero before the test begins. After the pointer rests on zero, back off the adjusting screw slightly to free the pin from the adjusting yoke in the mechanical zero-setting assembly.

PLACE THE METER IN ITS OPERATING POSITION

All electrical indicating meters operate best when they are placed in a position in which their pivots and bearings are aligned vertically. This reduces pivot friction to a minimum and allows the armature to turn more freely. To obtain this advantage, place the meter in the position where it is to be tested, and lay it down so its pointer will swing through a horizontal arc.

This is a general rule which has exceptions; an example is the position of the indicating meters on the Calibrator itself. These meters were calibrated to operate in a position 60° away from a horizontal position. For a meter which is calibrated to operate at a specific angle, duplicate the angle when you position it for testing.

DUPLICATE SPECIAL CALIBRATION CONDITIONS

If the meter to be tested is calibrated for use in a steel panel (the thickness will be specified), be sure to have the meter mounted in a piece of the proper material while you test it.

CONNECT THE METER

Use two wires which are large enough to carry output current from the Calibrator to the meter which you wish to test. For voltage measurements, current is always small and the lead size is not critical. But for D.C. ampere measurements, use at least a No. 12 A.W.G. wire size to carry the current.

Connect one wire from the COM. binding post at the bottom of the front panel to one meter terminal, and the other wire from the ± binding post to the other meter terminal. If the meter is a D.C. type, connect the COM. binding post to the negative meter terminal and the ± binding post to the positive meter terminal.

SET FUNCTION SWITCH

Turn the FUNCTION switch to the position which will furnish the desired output from the Self Powered Calibrator. The switch position will be determined by the type of meter which is to be tested. If the meter to be tested is a multimeter, the position for the FUNCTION switch will be determined by the type of circuit which is set in the multimeter.

The positions of the FUNCTION switch are A.C.V., D:C.V., D.C.uA., D.C.MA., 0–16 D.C.A., and RES. A.C.V. stands for alternating current voltage. D.C.V. stands for direct current voltage. D.C.uA. stands for direct current, measured in microamperes. D.C.M.A. stands for direct current, measured in milliamperes. 0–16 D.C.A. sets up a special direct current circuit which furnishes amperes on the single range indicated. RES. indicates that a fixed resistance is connected across the output terminals, and the self-contained power supply in the Calibrator is not connected, so no power is furnished to the output terminals.

SET RANGE SWITCH FOR VOLTAGE OR CURRENT

For A.C. voltage, D.C. voltage, or D.C. microamperes or milliamperes, set the RANGE switch at the position which will furnish enough output to cause full scale deflection on the meter which is to be tested. If the meter has more than one range, set the RANGE switch of the Calibrator at the position which will furnish enough output for each meter range while it is tested. Test the meter's ranges one at a time. The positions of the RANGE switch on the Calibrator are marked 1.6, 4, 8, 16, 40, 80, 160, 400, 800, and 1600.

NOTE

When the FUNCTION switch is set at 0–16 D.C.A., the output range is automatically established at 16 amperes D.C. The RANGE switch position does not have any effect on this condition.

SET THE POLARITY SWITCH AT +

For testing on the D.C. voltage and current circuits and the A.C. voltage circuits, set the POLARITY switch at its + position. This will be the normal position of this switch for most applications. If the output is D.C., the polarity of the output is negative at the COM. binding post and positive at the ± binding post. The other positions for this switch will have special uses for applications which are discussed further in these instructions.

ADVANCE THE OUTPUT CONTROLS TO APPLY SMALL VOLTAGE OR CURRENT

After the meter has been connected, and the FUNCTION, RANGE, and POLARITY switches have been set according to the above paragraphs, voltage or current may be applied to the meter under test.

Advance the control for the COARSE OUTPUT CONTROL. Turn the knob up slowly, watching the meter under test and also the corresponding meter on the front panel of the Calibrator. For a "suppressed-zero" type of meter, apply enough voltage or current to initiate deflection.

IF TESTED METER DOES NOT DEFLECT

If the meter under test does not respond properly when the output is sufficient for some small deflection, reduce the setting of the OUTPUT CONTROLS to zero again. Then examine the meter under test and determine whether or not to proceed with the test.

A complete lack of deflection will usually be caused by an open circuit. This could be in the meter armature or in the lead connections inside the meter case. In a voltmeter, it could be a series multiplier resistor. In a rectifier type A.C. voltmeter, it could be the rectifier. Or the open circuit may be in the leads and their connections between the Calibrator and the meter.

Too much deflection could be caused in a voltmeter with a shorted multiplier resistor, or in a current meter with an open shunt circuit. In any case, eliminate the trouble and then return the meter for testing.

APPLY ENOUGH VOLTAGE OR CURRENT FOR FULL SCALE DEFLECTION

Advance the COARSE OUTPUT CONTROL until you have applied enough voltage or current through the output terminals to cause full scale deflection of the meter under test. Watch the tested meter during this increase to see that its pointer is not driven off the scale. As you approach the full-scale value of voltage or current (indicated by the meter on the Calibrator), stop advancing the COARSE OUTPUT CONTROL when there is almost enough.

Then advance the FINE OUTPUT CONTROL until the Calibrator meter shows the exact amount required for a full scale deflection. Tap the tested meter lightly with your finger while the voltage or current is advanced to the full-scale value. This will help to overcome any bearing friction or stickiness which might cause an incorrect indication in the meter.

EVALUATE FULL SCALE INDICATION

Since enough voltage is applied to the circuit of the meter, or enough current is passing through it, to cause full scale deflection of its pointer, you can determine the accuracy at full scale. If the pointer shows exactly full scale, there is no error. However, if it shows either more or less than full scale, there is an error which is usually calculated in percent.

When the indication is low, use the scale divisions of error to calculate the percentage. If there are 50 equal scale divisions, an error of one division is a 2% error. If there are 40 divisions, each one represents 2½%. In any case, determine the percentage or error shown per scale division, and use this to calculate the total percent of error for the meter.

When the meter under test indicates beyond full scale, where there are no divisions, reduce the output voltage or current from the Calibrator until the tested meter shows exactly full scale. Then calculate the percent of error with this formula:

$$E = \frac{C-F}{C} \times 100$$

where E = percent of error
C = correct voltage or current for full scale deflection
and F = actual voltage or current which causes full scale deflection

EVALUATE PARTIAL DEFLECTIONS

Reduce the voltage or current applied from the Calibrator to the amount required for 3/4 of full scale deflection. Tap the meter under test to overcome any bearing friction or stickiness. Then check the meter indication. If the pointer shows exactly 3/4 scale, there is no error. However, if it shows slightly more or less than 3/4 scale deflection, there is an error which will be calculated as a percent of full-scale deflection.

Note that the percent of error at any point on the scale is quoted in terms of full-scale deflection values; it does not necessarily represent the percentage of actual indication error unless the indication is full-scale.

Reduce the voltage or current applied from the Calibrator to the amounts required for 1/2 scale deflection and 1/4 scale deflection in turn. Observe the error of indication at each point. Rate the percent of error against the amount required for full-scale deflection in each case.

REDUCE OUTPUT TO ZERO BEFORE DISCONNECTING METER

Always reduce the settings of the COARSE and FINE OUTPUT CONTROLS to zero before you disconnect the leads from the output to the meter under test. Then wait, if necessary, for the meter on the Calibrator to show that the output has dropped to zero.

GALVANOMETERS AND ZERO CENTER METERS

There are many varieties of meters which have their zero deflection point somewhere in the scale of the meter rather than at an extreme end of the scale. Zero is usually at the center of the scale for such instruments, but may be at any point in the scale. Such instruments are always D.C. voltage or current meters. They deflect the pointer in one direction for one polarity, and in the other direction for the reversed polarity.

When testing such a meter with the Self Powered Calibrator, check the deflection in one direction according to the above directions, and then check again with the polarity reversed to provide the opposite deflection. To reverse polarity, turn the POLARITY switch to its proper position.

MULTI-RANGE VOLTMETERS

When you test multi-range D.C. or A.C. voltmeters, check the lowest range on the instrument first. Then test for only one point on each of the higher ranges in turn. The first test will show the basic movement accuracy at various points across the scale; tests on higher ranges will reflect the accuracy of multiplier resistances which are added in series for the higher ranges. When the meter accuracy appears to change from one range to another, this is due to the multiplier resistances only, because the accuracy of the basic movement will remain the same throughout all its ranges.

MULTI-RANGE CURRENT METERS

When you test multi-range D.C. microammeters, milliammeters, or ammeters, or any combination of them, check the lowest range on the instrument first. Then test for only one point on each of the higher ranges in turn. The first test will show the basic movement accuracy at various points across the scale; tests on higher ranges will reflect the accuracy of shunts which are used for the higher ranges. When the meter accuracy appears to change from one range to another, this is due to the parallel shunt resistances which are used for the higher ranges. The accuracy of the basic movement is not affected by the range in which it is connected.

MULTIMETERS

The term Multimeter is used to define a combination instrument which will measure a variety of electrical conditions. It usually has a variety of ranges for each type of circuit.

A multimeter may measure voltage, either D.C. or A.C. or both, direct current, or any combination of these units. Test a multimeter first on its lowest current range, if it has one. Then check the other current ranges. Next test its lowest D.C. voltage range, and then the higher D.C. voltage ranges. Next test its lowest A.C. voltage ranges. Finally, check the resistance ranges.

WHAT TO DO WHEN ERROR APPEARS ON ALL RANGES

When a multimeter shows similar error on all ranges, the basic meter itself is suspected. Confirm this suspicion by isolating the basic movement from all other circuitry in the instrument, and testing it alone.

The basic movement is usually a D.C. microammeter or D.C. milliammeter. It's sensitivity is indicated by the ohms-per-volt rating of the D.C. voltage circuits. For example, if the multimeter has a D.C. voltage sensitivity of 20,000 ohms-per-volt, its basic meter requires 50 microamperes through it for full scale deflection. If the multimeter has a D.C. voltage sensitivity of 1000 ohms-per-volt, the basic meter requires 1 milliampere through it for full scale deflection.

Use Ohm's Law to calculate the direct current sensitivity for the basic meter in any multimeter when you need to test the basic meter separately.

WHEN ERROR APPEARS ON D.C. VOLTAGE RANGES ONLY

When a multimeter indicates correctly for its other types of circuits, but shows errors in one or more D.C. voltage ranges, the trouble will usually be found in the D.C. multiplier resistors. A knowledge of the circuit is helpful here, since the multimeter circuit can use either a single resistor for each range, or more resistance may be added in series for each higher range of the instrument.

The latter, or cumulative, method of circuit construction is the more common. In it, an error which appears in one range, due to a change in the resistance value for the multiplier which is added in series for that range, will cause some error for all higher ranges. The percent of error decreases for each of the higher ranges in turn. Of course, an open multiplier resistor will cause zero deflection for its own range and for all higher ranges.

WHEN ERROR APPEARS ON A.C. VOLTAGE RANGES ONLY

When a multimeter indicates correctly for its other types of circuits, but shows errors in one or more A.C. voltage ranges, the trouble may be found in the A.C. multiplier resistors or in the rectifier. The rectifier, and its associated calibrated shunt and series resistors, will cause errors on all A.C. voltage ranges whenever there is any trouble in it.

The A.C. voltage multiplier resistors are usually separate from those for the D.C. voltage circuits, but are arranged in a similar type of circuit. Any troubleshooting procedures will be similar to those for D.C. multiplier resistors.

WHEN ERROR APPEARS ON CURRENT RANGES ONLY

When a multimeter indicates correctly for its other types of circuits, but shows errors in one or more of its current ranges, the trouble can usually be found in its shunt circuits. The basic movement usually has a shunt, even for its lowest range. For its higher ranges, there may be a different shunt for each range, or there may be a tapped point in a series of resistors which form a ring shunt.

In the individual type of shunt circuit, an increase of the resistance value in the shunt will cause an increased meter indication, while a decrease of resistance will reduce the meter indication.

In a ring shunt circuit, the same errors will be apparent for all ranges up to and including the one where the erratic resistor is in the parallel circuit. When the erratic resistor is connected in series with the basic meter (for all higher ranges), the meter indication errors will be reversed; an increased resistance will decrease the meter deflection, or a decreased resistance will increase the meter deflection.

SECTION IV

OPERATION

OHMMETER CIRCUITS

When the FUNCTION switch is set at RES., an accurately measured resistance is connected between the output terminals. There is no power applied to these output terminals from the Calibrator; it does not matter whether or not the normal A.C. power input is connected or turned on. Any meter deflection for ohmmeter tests will be due to current through the circuit from the self-contained battery, batteries, or power supply in the ohmmeter which is being tested.

The Simpson Self Powered Calibrator Model 2600 will furnish any one of nine accurate resistances across the output terminals. The position of the RESISTANCE range switch will determine which of the resistors is connected. Evaluate the ohmmeter in accordance with the accuracy with which it indicates these resistance values.

SET FUNCTION SWITCH AT RES.

Before you connect any ohmmeter across the output terminals of the Calibrator, set the FUNCTION switch on the front panel at RES. This will eliminate any possibility of applying power accidentally to the ohmmeter circuit.

SET POLARITY SWITCH AT SHORT

Turn the POLARITY switch to its SHORT position. This will apply a direct short circuit across the output circuit for a zero setting of the ohmmeter. Set the ohmmeter zero-set control for an indication of zero ohms on its scale.

CONNECT OHMMETER TO OUTPUT TERMINALS

Connect the two leads for the ohmmeter to the output terminals of the Calibrator. If the ohmmeter circuit is a part of a Vacuum Tube Voltmeter, connect it to its necessary power source and turn on its power; allow sufficient time for the instrument to warm up.

SET POLARITY SWITCH AT OPEN

If there is an adjustment on the ohmmeter for open circuit (infinite ohms), set the POLARITY switch at OPEN and adjust the ohmmeter circuit for an indication at infinity. Return the POLARITY switch to SHORT again

and recheck the zero ohms indication; in most ohmmeters, there will be a reaction between the settings of these two controls. Work back and forth as necessary to get the ohmmeter to indicate correctly at both zero and infinity.

IF OHMMETER WILL NOT DEFLECT TO FULL SCALE

When the ohmmeter controls cannot be adjusted to provide full scale deflection, the trouble is almost always in the voltage source for the ohmmeter itself. In most ohmmeters, voltage is furnished from dry cell batteries which are self-contained. If you cannot obtain full scale deflection on the meter, replace the battery (or batteries, if there are more than one in the circuit), and then return the ohmmeter for further testing.

MEASURE THE STANDARD RESISTANCES

After you have the ohmmeter controls set for zero and infinite indications with the SHORT and OPEN circuit in the Calibrator, set the POLARITY switch at either + or −. Either switch position may be used because there is no polarity difference in the resistor connections. Then measure the Calibrator resistors with the ohmmeter.

Set the RESISTANCE switch at its 1 Ω position and read the ohmmeter set for its lowest range. Then turn the RESISTANCE range switch to its 10 Ω position and read the ohmmeter again. Check all the resistance readings which have significant points on the lowest range of the ohmmeter.

Set the ohmmeter range switch at its next higher range. Check the full scale deflection with the aid of the POLARITY switch; adjust as necessary. Then set the POLARITY switch at either + or −, and turn the RESISTANCE range switch of the Calibrator to each of the values of resistance which have significant points for reading on that ohmmeter range.

Check each higher ohmmeter range in a similar manner, matching the resistance values which are furnished from the Calibrator against the resistances indicated in each range of the ohmmeter.

EVALUATING THE OHMMETER INDICATIONS

The scale of resistance indications in an ohmmeter is always non-linear. It is logarithmic, or approximately so. When the ohmmeter under test indicates the values of resistance which can be connected from the Calibrator, it may show these values exactly, or it may show slightly more or less than the correct amount.

Tolerances for ohmmeter accuracies are usually quoted in terms of degrees of arc on the scale. The accuracy of the resistance indications is determined by the physical accuracy of the pointer position, rather than in terms of any percentage of indicated resistance. A common tolerance is ±3°. This would mean that each resistance which is checked should be indicated by the pointer deflecting to an area within 3° above or below the point where such resistance value is marked on the scale. The actual amount or resistance error may be only a fraction of an ohm, or it may be thousands of ohms, depending on the range and the part of the arc which is in use. But tolerance is defined in terms of meter pointer deflection rather than any resistance values.

SECTION V

OPERATION

OTHER INDICATING METERS

GENERAL INFORMATION

Electrical indicating meters are used for many circuit applications in which the measured units are different from those which are shown on the Simpson Self Powered Calibrator Model 2600. For example, a meter could show decibels, percent of modulation, degrees of temperature, inches of thickness, lumens of light, or any of the myriad of units in limitless fields of application.

Any such meter will operate with some form of transducer, which will translate the units to be indicated into equivalent electrical units, either units of voltage or units of current.

To test any such meter, you must first know the relation between the units of measure on its dial and the amount and kind of voltage or current which will cause pointer deflection. Then you can produce the proper electrical conditions to cause pointer deflection and determine the condition of the meter.

RELATE SCALE UNITS TO ELECTRICAL UNITS

For some meters, the relation between the units on the meter scale and voltage (or current) are known. In others, the relation will depend entirely on the type of trans-

ducer and the circuit application for which the meter was designed to obtain this relationship.

Ask the equipment manufacturer for the electrical characteristics of the meter circuit, and specify that the information is for test purposes. Most manufacturers will provide the information, together with any unusual conditions which may pertain to testing the meter which is installed in their circuit. As an example, the circuit might contain an internal voltage source; to test the circuit, you might be asked to remove the internal source of voltage and to replace it with some particular resistance when you apply test voltage or current to the meter's circuit.

SECTION VI

MAINTENANCE

HANDLE WITH CARE

The Simpson Self Powered Calibrator Model 2600 is intended to be used as a reliable and accurate source of electrical conditions. It is not what would normally be considered a fragile or delicate instrument. Still, careful handling will assist the Calibrator to keep the accuracy which was in the instrument when it was new. Always protect it from vibration and shock. Keep it reasonably clean and free from all corrosion and mold growth. No lubrication is necessary for any of the component parts, but they should always operate freely, without any catching or binding.

NOTE - Repair and Calibration Service

For replacement of any part which affects calibration, or for repair or recalibration of the instrument, the unit must be returned to the Repair Department at the factory or to one of the official Simpson Repair Stations. First write a letter to the Repair Station or the Repair Department at the factory; describe the work which you wish to have them perform and include the Serial No. of your Calibrator. They will schedule the work and send you shipping instructions, including suggestions for packing and identification.

OPEN THE FRONT PANEL

For access to the parts which are located inside the cabinet of the Calibrator, open the front panel of the instrument. There are seven screws around the sides and top of the panel which must be removed. Then the panel folds down on a continuous hinge mounted at the bottom. Use the two convenient handles at the sides of the front panel to pull it forward after the seven screws have been removed. Do not pull on the switch knobs to open the panel. Do not remove screws at bottom of panel.

ALL PARTS ARE EASILY REACHED

All of the component parts of the Calibrator are easy to reach when the front panel is open. They are mounted in three general groups. The heaviest parts are mounted on the inside of the rear of the cabinet; all operating controls and the group of precision resistors for the OHMS circuit are mounted on the rear of the front panel; and the remaining circuit components are mounted on a hinged sub-panel attached to the rear of the front panel.

PARTS MOUNTED IN REAR OF CABINET

Beginning at the left side inside the cabinet, there is a D.C. voltage and microampere supply an a chassis. It has a rectifier tube, a filament transformer, a high voltage transformer, a filter choke and two filter capacitors, together with a terminal strip, all mounted on the top of chassis. A 2uf, 2000 v filter capacitor is mounted under this chassis, and is also a part of the D.C. output filter.

At the center in the rear of the cabinet is a large potential transformer for the A.C. voltage supply. It has a variety of tapped connections which represent very accurately proportioned turns ratios for A.C. output voltage accuracies.

At the right in the rear of the cabinet is the D.C. current supply. It has a transformer, filter choke, a large selenium rectifier, and a capacitor, together with a terminal strip, mounted on the top of the chassis. There is a 50 ohm bleeder resistor mounted at the base of the filter capacitor under the chassis.

In front of the current supply chassis is the large high current shunt. This is calibrated before the unit leaves the factory. The leads connected between this shunt and the other parts of the Calibrator are large, to carry the high current adquately.

PARTS MOUNTED ON THE REAR OF THE FRONT PANEL

All parts which have control knobs and indications on the outside of the front panel are mounted on the rear of the panel. A sub-panel with resistors for the OHMS circuits is also on the rear of the panel.

A single resistor is used for the total resistance for each range except 100 megohms: to assure accuracy in this large amount of resistance, there are three individual resistors connected in series. Two of the resistors make up an 80 megohm matched pair, and the third is a 20 megohm resistor. The resistors for the lowest five ranges are Simpson wound-bobbin type. The resistors for the highest four ranges are deposited film type commercial resistors with the close specified tolerance.

SUB-PANEL HINGED TO REAR OF FRONT PANEL

The sub-panel is mounted on the rear of the front panel with a continuous hinge. For access to the indicating meters and their calibrated resistors (mounted near each movement), remove the 3 screws at the top edge of the sub-panel. Then raise the sub-panel on its hinge.

PARTS MOUNTED ON THE SUB-PANEL

At the left rear are the bridge rectifier, shunt and series resistors R55 and R56, and the series multiplier resistance, R11, for the A.C. voltage circuit. Resistance R11 is made up with 14 resistors all in series. Eleven of these have 250 ohms resistance each. The last three resistors are calibrated to the exact requirements of the meter movement on the front panel for A.C. volts, and will vary in value between instruments. The total series resistance is approximately 3000 ohms.

Resistor R55 has a nominal value of 42 ohms, and resistor R56 has a nominal value of 960 ohms. Each of these is a Simpson wound-bobbin, and is calibrated directly to the characteristics of the four germanium rectifiers which make up the bridge type rectifier assembly.

At the right of the A.C. meter accessory group are the multiplier resistors for the D.C. voltage and microampere ranges, and the one megohm resistor for series connection for the microampere circuit. All the range resistors in the Simpson Self Powered Calibrator Model 2600 are connected in a cumulative circuit.

At the right side of the sub-panel are all the resistors which are in the D.C. milliampere circuit except R54, which is mounted on the bottom of the main cabinet. The resistors in this group are R22 through R41. Some of the resistance values require two or more resistors connected in a combination for resultant resistance with a consistent accuracy.

At the right rear of the sub-panel are two relays which are used to connect the output of the current circuit directly to the output terminals for the 0–16 D.C.A. range. These relays operate to connect each side of the line to an output terminal. Inspect and clean the contacts of these relays occasionally. To clean them, draw a piece of clean paper between the contacts while you press down lightly on the relay armature. If the points become burned or pitted, replace them with new points to maintain low resistance contact for maintained accuracy of the high current circuit.

LIST OF REPLACEABLE PARTS

The following parts list is furnished for your convenience during maintenance of your Self Powered Calibrator. It contains all parts which may be furnished for replacement and also those parts which are shown on the overall schematic diagram, figure 3, but should not be replaced in the field. Such parts are listed as an aid in identification, but their replacement has a direct and definite affect on the calibration of the Calibrator.

PARTS LIST

Circuit Symbol	Description	Simpson Part No.
C1	Capacitor, 6000 μf, 10 volts	1–113567
C2	Capacitor, 2 μf, 2000 volts	1–116150
C3	Capacitor, 2 μf, 2000 volts	1–116150
CH1	Choke Coil, current circuit filter	10–890263
CH2	Choke Coil, high voltage filter	1–117044
CR1	Rectifier, selenium, for current output	1–116142
CR2	Rectifier assembly, A.C. voltmeter. (Not for field replacement)	
F1	Fuse, 3.2 ampere 125 volts, type 3AG SLO-BLO	1–116145
I1	Lamp, Neon, T-3¼, NE-51, bayonet base, single contact	1–117442
K1	Relay, 15 ampere contacts, 110 V.A.C. coil	1–116148
K2	Relay, 15 ampere contacts, 110 V.A.C. coil	1–116148

WARNING – DANGER

This instrument can deliver voltages which are dangerous to touch. Prevent injury, or even death, by setting both output controls at zero and turning power off before touching the binding posts, leads, or any instrument which is connected.

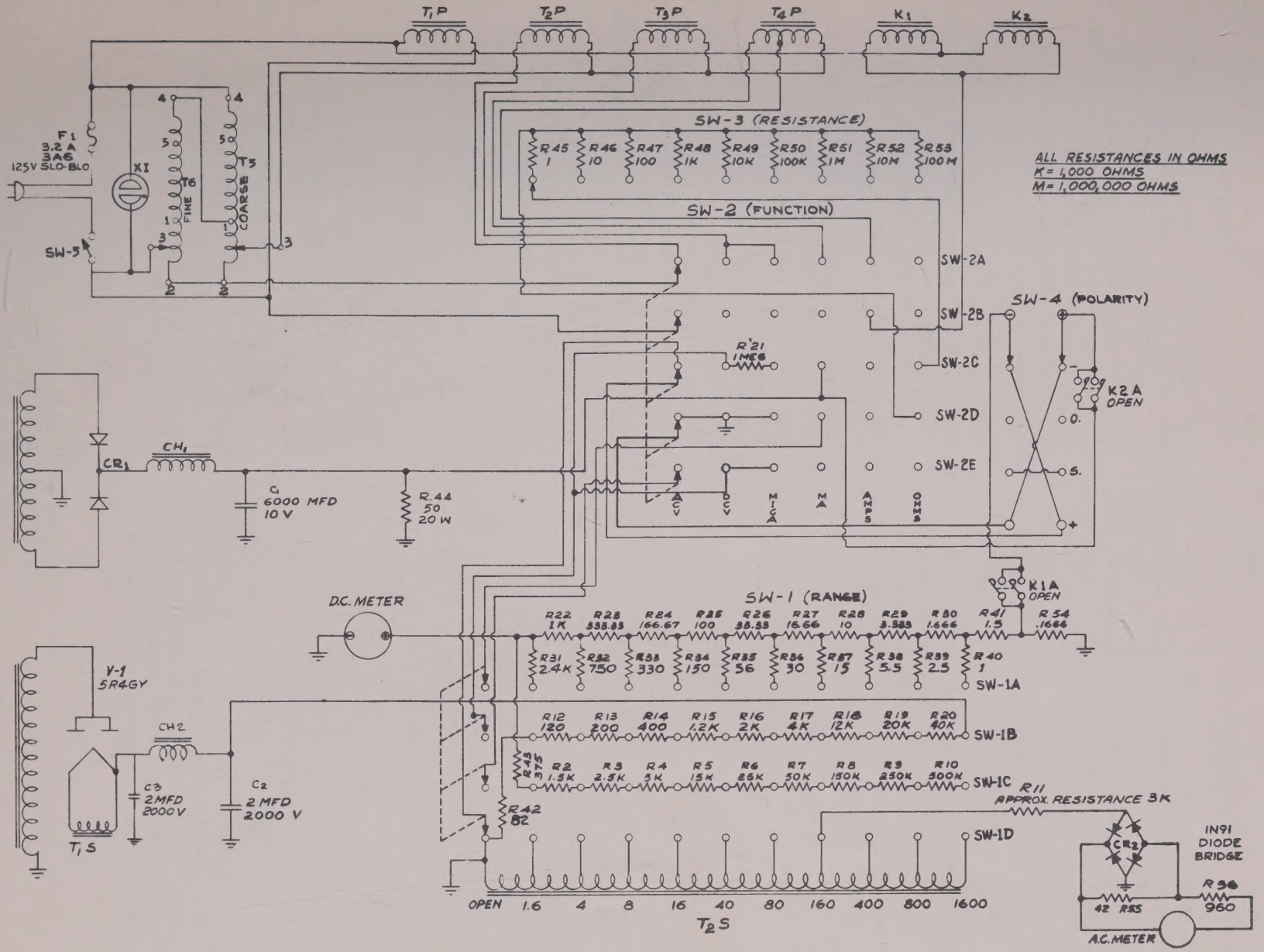


FIGURE 4. OVERALL SCHEMATIC DIAGRAM, SIMPSON SELF-POWERED CALIBRATOR MODEL 2600

PARTS LIST

Circuit Symbol	Description	Simpson Part No.
R1	Part number not used	
R2	Resistor, 1.5 K ohms ±0.1%	1–116182
R3	Resistor, 2.5 K ohms ±0.1%	1–116181
R4	Resistor, 5 K ohms ±0.1%	1–116180
R5	Resistor, 15 K ohms ±0.1%	1–116179
R6	Resistor, 25 K ohms ±0.1%	1–116178
R7	Resistor, 50 K ohms ±0.1%	1–116177
R8	Resistor, 150 K ohms ±0.1%	1–116176
R9	Resistor, 250 K ohms ±0.1%	1–116175
R10	Resistor, 500 K ohms ±0.1%	1–116174
R11	Resistance; total calibrated for instrument; uses 11 each resistors, 250 ohms, bobbin, Simpson part no. 10–675012, plus necessary added series values (Not for field replacement)	
R12	Resistor, 120 ohms ±5%, 2 W	1–116440
R13	Resistor, 200 ohms ±5%, 2 W	1–116441
R14	Resistor, 400 ohms ±5%, 10 W	1–116452
R15	Resistor, 1200 ohms ±5%, 10 W	1–116453
R16	Resistor, 2000 ohms ±5%, 10 W	1–116454
R17	Resistor, 4000 ohms ±5%, 10 W	1–116455
R18	Resistance, 12000 ohms, c/o two each resistors 6000 ohms, ±5%, 20 W	1–116456
R19	Resistance, 20000 ohms, c/o two each resistors 10000 ohms ±5%, 20 W	1–116185
R20	Resistance, 40000 ohms, c/o four each resistors 10000 ohms ±5%, 20 W	1–116185
R21	Resistance, 1 megohm, c/o two each resistors 500 K ohms ±0.1%	1–116174
R22	Resistor, 1000 ohms, spool assembly	10–675003
R23	Resistor, 333.33 ohms, spool assembly	10–675011
R24	Resistor, 166.67 ohms, spool assembly	10–675013
R25	Resistor, 100 ohms, spool assembly	10–675016
R26	Resistor, 33.33 ohms, spool assembly	10–675027
R27	Resistor, 16.66 ohms, spool assembly	10–675024
R28	Resistor, 10 ohms, spool assembly	10–675023
R29	Resistance, 3.333 ohms, c/o two each resistors 6.666 ohms, spool assembly	10–675022
R30	Resistance, 1.666 ohms, c/o four each resistors 6.664 ohms, spool assembly	10–675021
R31	Resistor, 2.4 K ohms ±5%, 2 W wire wound	1–116442
R32	Resistor, 750 ohms ±5%, 2 W, wire wound	1–116443
R33	Resistor, 330 ohms ±5%, 2 W, wire wound	1–116444
R34	Resistor, 150 ohms ±5%, 2 W, wire wound	1–116445
R35	Resistor, 56 ohms ±5%, 2 W, wire wound	1–116446
R36	Resistor, 30 ohms ±5%, 2 W, wire wound	1–116447
R37	Resistor, 15 ohms ±5%, 2 W, wire wound	1–116448
R38	Resistance, 5.5 ohms, c/o two each resistors 11 ohms ±5%, 2 W, wire wound	1–116449
R39	Resistance, 2.5 ohms, c/o two each resistors 5 ohms ±5%, 2 W, wire wound	1–116450
R40	Resistance, 1 ohm, c/o two each resistors 2 ohms ±5%, 2 W, wire wound	1–116451
R41	Resistance, 1.5 ohms ±0.1%, c/o four each resistors 0.49 to 0.51 ohm, spool assembly, and one resistor 1 ohm ±1%	10–675036
R42	Resistor, 82 ohms ±5%, 2 W, wire wound	1–116439
R43	Resistor, 375 ohms, spool assembly	10–675008
R44	Resistor, 50 ohms, 20 W, type 2D	1–116190
R45	Resistor, 1 ohm, wire wound (Not for field replacement)	
R46	Resistor, 10 ohms, wire wound	10–675023
R47	Resistor, 100 ohms, wire wound	10–675016
R48	Resistor, 1000 ohms, wire wound	10–675003
R49	Resistor, 10000 ohms, wire wound	10–675002
R50	Resistor, 100,000 ohms	1–113427
R51	Resistor, 1 megohm	1–113392
R52	Resistor, 10 megohms	1–113434
R53	Resistance, 100 megohms, c/o one matched pair for 80 megohms, Simpson part no. 1–113353, and one each resistor, 20 megohms, Simpson part no. 1–113528	
R54	Karma shunt assembly, calibrated to 0.1666 ohms between ends of open wire leads (Not for field replacement)	
R55	Resistor, 42 ohms, spool assembly	10–675028
R56	Resistor, 960 ohms, spool assembly	10–675004
SW1	Switch, RANGE for voltage and current	1–116147
SW2	Switch, FUNCTION	1–116144
SW3	Switch, RESISTANCE	1–116127
SW4	Switch, POLARITY	1–116143
SW5	Switch, OFF-ON, D.P.S.T.	1–114777
T1	Transformer, for 5R4GY filament	1–116125
T2	Transformer, A.C. potential, w/10 taps	1–116128
T3	Transformer, for D.C. voltage output	10–890265
T4	Transformer, for milliamperes and amps	10–890264
T5	Powerstat voltage control, 3A, 60 cycles, for COARSE OUTPUT CONTROL	1–116149
T6	Powerstat voltage control, 3A, 60 cycles, for FINE OUTPUT CONTROL	1–116149
XI1	Light, Indicator, holder	1–116172

WARRANTY

SIMPSON ELECTRIC COMPANY warrants each instrument and other articles of equipment manufactured by it to be free from defects in material and workmanship under normal use and service, its obligation under this warranty being limited to making good at its factory any instrument or other article of equipment which shall within 90 days after delivery of such instrument or other article of equipment to the original purchaser be returned intact to it, or to one of its authorized service stations, with transportation charges prepaid, and which its examination shall disclose to its satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on its part, and SIMPSON ELECTRIC COMPANY neither assumes nor authorizes any other persons to assume for it any other liability in connection with the sale of its products.

This warranty shall not apply to any instrument or other article of equipment which shall have been repaired or altered outside the SIMPSON ELECTRIC COMPANY factory or authorized service stations, nor which has been subject to misuse, negligence or accident, incorrect wiring by others, or installation or use not in accord with instructions furnished by the manufacturer.

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